Beyond Reductive Systems Approaches:

From Urban Metabolism and the Circular Economy to Circles of Sustainability

New introduction based on an argument about circular economics, circular urban metabolism
Critique
'systems dynamics': need to use this term

Responding Adequately to the Coming Catastrophe

Leaving aside comforting stories about the gradual changes that global warming is bringing, there is no way around the underlying reality. The planet is rapidly becoming uninhabitable for humans—except perhaps for those who can afford to shield themselves from the intensifying change. The world is in crisis, and cities are at the centre of the current maelstrom. It is a complicated period during which we are struggling to find adequate ways to characterize the dominant urban challenges and to respond adequately to those challenges. It is indicative of this complexity that we live in a period that is simultaneously being criticized as 'the Anthropocene' and, more optimistically, called 'the Urban Age'. This is the era in which humans have had a profound impact upon the earth's ecological systems. It is also the period during which the planet has become overwhelmingly urbanized. Bringing together these contentions has led to the 'obvious' but somewhat misleading claim that cities provide the basis of a sustainable future.

Rather than the simple point that it appears to be, the claim that cities provide the basis for a sustainable future presents us with a confronting paradox. Yes, developing a positive and sustainable mode of urban living is the only way that we will be able to sustain social life as we know it past the end of this century. But it is equally the case that cities are at the heart of the ecological problems facing this planet. Let us be clear here. For all of its distortions, the double cliché that 'cities are the future' and 'cities are the engines of economic growth' is based on the skewed presumption that high mass-consumption—anathema to positive sustainability—continues as the assumed promise of contemporary urban life.

The other side of the equation is also confronting. Because of the world's current population growth, returning to a predominance of rural living is no longer viable for the future of humanity. Sustainably increasing the density of our urban settlements along with increasing energy-efficiency and using less resources *is* the only alternative, at least when treated as one part of a comprehensive revolution in how we live. But this is not because cities are essentially more sustainable than rural settings. It is rather because, given current global population, building on small, self-contained plots of land can no longer save the planet. Well-planned density is necessary to slow down our colonization of the planet.

This paradox is associated with a second distorting contradiction. The very activities that have been the basis for mainstream human flourishing—often summarized in the hope-filled concept of 'economic progress'— have come to be the prime reason for our current crisis. When Charles Dickens wrote *A Tale of Two Cities*, seventy years after the French Revolution, his words appeared to confront this very point:

> it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way—in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only (Dickens, 1859: 3).

Most commentators since then have missed the point of this passage. It was not for Dickens the 'best of times' or 'the worst of times' *per se*. It was rather a new time where 'superlative degree of comparison' began to reign supreme. It had become the age of hyperbole, through which we are still living. Dickens' words speak of a new world of starkly different descriptions and prognoses of hope and despair, with little expressed publicly in between. The people of the two cities, Paris and London,

or at least their less-than-democratic planners and politicians, were confronted with difficult choices to make about their future—and rhetorical excess ruled.

Perhaps as a consequence, over the next century to the present, with limited exceptions, neither of those cities found ways of getting beyond the vacillating rhetoric and the galloping problems of urban bloating. Nor, for most part, did other cities and urban communities on this planet. For all of the good work of committed infrastructure planners and urban activists, problems ranging from tedious traffic congestion and privatisation of common spaces to bloating resource-use and urban violence continued to confront social life. Now, in the early part of the twenty-first century, we are still too-often engaged in Dickens' 'superlative degree of comparison'. On the one hand, it suggested that technological renewal or ecological modernization can save the planet. On the other hand, it is proclaimed that individual actions in response to planetary crisis will not add up to making a significant difference. In continuity with earlier competing descriptions of what needs to be done—and with a thousand qualifications—both responses are defensible. However, they need to be brought into a synthetic relation with each other that meaningfully confronts the planetary crisis (Wallace-Wells, 2019). And this needs to be done in the context of the searing recognition that significant changes have occurred over the past few decades to make debates over superlatives increasingly empty.

First, the concepts of 'the Anthropocene' and 'climate change' have become mired in very debates that were meant to be clarifying. The notion of 'the Anthropocene' goes back to the nineteenth century when Antonio Stoppani, an Italian contemporary of Dickens', coined a cognate term, but it has taken until the last few years, following Paul Crutzen and Eugene Stoermer's intervention in 2000, for the concept to gain any traction. And, almost as soon as the concept entered contemporary discourse, it was either reduced to its technical meaning—a measurable impact upon the geological substrate of the earth through leaving sedimented traces—or alternatively, like the contestation of climate change, its meaning was variously disputed by right-wing populism as a relative truth or a post-truth scam.

Second, the modern dialectical struts of hope and despair have now allowed for the long-term deferral of fundamental action on basic questions—whether structural or individual. Fundamental action has slipped into tragic inertia. Leaving aside the continuing passions of populism or the despair of nihilism, there is now a constant deferral in much of the mainstream of more than incremental structural changes to business–as-usual. This is carried by the contradictory idea that, on the one hand, we must do 'something', but on the other, that life on our planet can go on much as before if it is supported by enhanced technological platforms.

Third, the stakes are now much higher. Something new is clearly happening, vaguely signalled by the concept of 'the Anthropocene'. We are the first human civilization with the capacity to override prior senses of planetary boundaries and limits. In other words, while continuing to degrade nature, we have begun to re-constitute the nature of nature. We can now split atoms, recombine genetic material, disrupt ripples in space and time, and play with nucleotides and chromosomes, the building blocks of all life-forms on earth. This is a qualitatively step beyond belching out black smoke or clearing tropical rain forests for beef production, and signals the constitutive level of the crisis.

In the meantime, the earth's climate patterns continue to be fundamentally destabilized. According to a recent report by the Intergovernmental Panel on Climate Change (IPCC), the world reached 1°C global warming above pre-industrial levels in 2017, and is heading towards 1.5°C within a decade or so—the *high confidence* range predicted for this threshold is between 2030 and 2052. With more than 2°C global warming, it has been suggested that the world will head towards global chaos, albeit with more severe impact in the equatorial regions. To give some sense of the difference between the two thresholds, at 1.5°C, the IPCC estimates that around 80 per cent of coral reefs will be gone; at 2°C it will be 99 per cent destroyed (IPCC, 2018).

Some critics have talked about how we are sleep-walking towards our own demise. However, while the possibility of degrading life as we know it is simply real, the deferral of structural change in the form of the economy and culture is much more active than that. Nobody is asleep. Keeping social life on course for disaster entails real effort. In effect, it amounts to an energetic projection of business-with-a-changed-rhetoric while supercharging the technological infrastructure to support social life as we know it. The Smart Cities' rhetoric, for example, is replete with 'green' images of the planet, while doing little to attend to the coming chaos. And hyperbolic announcements continue to be made about relatively weak (even if sometimes useful) alternatives—traffic management systems that will supposedly give people the capacity to skirt neatly around traffic snarls; cloud systems that mean that

we can collect even bigger data sets for (questionable) interpretation; mobile phone apps that allow people to learn more about the streets through which they move without stopping to use their senses to fully experience those streets. All these developments tend to defer the need to rethink fundamentally the form of the hyper-mobile, consumption-heavy and growth-based social freedom that presents itself as the *raison d'être* of 'sustainable development'. This is the paradoxical 'revolutionary' stasis that allows us in the metropolitan West to stay basically within the same growth paradigm, while everything swirls around us suggesting basic reconsideration.

Given this context, how can we best map the challenges of urban sustainability as a guide to positive practice? How can we influence mainstream decision-making that requires assessment processes, statistics, indicators and markers in order to defend change? This essay sets out to bring together two very different approaches to sustainability—the urban metabolism approach, and the Circles of Social Life method. These are both systems approaches. There is no attempt to reinvent the wheel here. What is being proposed is only new in the juxtaposition—a more reflexive synthesis of old and new work, bringing new sensitivities to old problems.

The strength of the various urban metabolism and systems dynamics approaches is that they can dynamically map and measure the material inputs and outputs to a system. This is what some call 'stocks and flows', defined as entities that can be accumulated or depleted in relation to processes or flows across time, processes that effect the measurable levels of those entities. Measuring urban metabolism thus tends to be operationalized in *quantitative* terms. The strength of the Circles method is that it sensitizes researchers and practitioners to the intersectional *qualitative* complexity of social life, bringing together domains, perspectives, and aspects across all of social life in relation to cross-cutting critical issues. The Circles method thus has its basis in qualitative assessment of relational values.

The central argument of this essay is that a qualifying method, something akin to the Circles approach, is necessary for making the best systems-dynamics approaches work more sensitively. This has become more imperative across the half century since systems-dynamics approaches first emerged. Firstly, since the middle of last century as the domain of economics has moved from the immaculate child of capitalism to be enthroned as a demanding monarch,[1] all considerations of measurement and value and therefore all measures—and not just those of weights and volumes—have come to assume a universal logic of commensurability: money. Second, as computer-generated algorithms have grown up during the same period to become the king's favoured accounting system, we seem to have become less and less interested in the black box of ecological, economic, political and cultural assumptions that frame such algorithmic calculations. Who has time these days to read the fine print?

The essay begins with two orienting sections that provide introductions to the urban metabolism approach and Circles of Social Life method respectively. It then goes onto pose a series of questions as a way of refining the two approaches in relation to each other. What do the metaphors of 'metabolism' or 'circles' mean for systems complexity? What should be the subject of a metabolic or circles analysis? Can subject-based approaches bring in complex understandings of process?

System Dynamics and integrated Assessment Models

The study of system dynamics—that is, the study of closed systems with attributed determinative factors which can be analysed algorithmically—began in the mid-twentieth century. It translated engineering tools for studying load problems and business methods for modelling the growth of corporations into broader systems models. This was not an auspicious beginning. But in some hands, it proved to be quite radical, particularly in opening up questions of causation. The key issue to be resolved was the difficulty of discerning the core causes of change in complex systems. As Jay Forrester, one of the early translators of the systems dynamics approach, put it, 'a complex system is even more deceptive than merely hiding causes. In the complex system, when we look for a cause near in time and space to a symptom, we usually find what appears to be a plausible cause. But it is usually not the cause. The complex system presents apparent causes that coincident symptoms' (1969: 9–10).

His pioneering work and subsequent book *World Dynamics* (1971) became the basis for the famous *Project on the Predicament of Mankind*, one of the earliest attempts to map algorithmically the

[1] Prior to the 1920s, economic terms with the definite article 'the' such as 'the economy' or 'the market' were rarely sighted beasts, still held in check by a more encompassing sense of the social.

Anthropocenic crisis. It mathematically modelled what it said were the five basic factors that determine the sustainability of this planet: population, agricultural production, industrial production, consumption of non-renewable resources and pollution. That project in turn became the basis for one of the most important and controversial books of the twentieth century, *Limits to Growth*, produced by the Club of Rome (Meadows, *et al.,* 1972). That book had two conclusions: Firstly, 'If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years.' Computerized modelling was fundamental to this conclusion. Second, they projected, 'It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future' (Meadows, *et al.,* 1972: 23–4). This would require decision-making based on answering some basic questions:

> Should there be more people or more wealth, more wilderness or more automobiles, more food for the poor or more services for the rich? Establishing the societal answers to questions like these and translating those answers into policy is the essence of the political process. Yet few people in any society even realize that such choices are being made every day, much less ask themselves what their own choices would be. The equilibrium society will have to weigh the trade-offs engendered by a finite earth not only with consideration of present human values but also with consideration of future generations. (Meadows, *et al.,* 1972: 181–2)

Like Jay Forrester, the Club of Rome authors argued for the existential necessity of moving from a paradigm of developmental growth to one of equilibrium. It is worth looking back at these contested books from nearly half a century ago, because we can now test some of their projections against realized trends. For example, the Club of Rome authors broadly estimated that there would be 7 billion people on the planet in the year 2000 (we did not reach that figure until 2011). However, the predictive power of the method is not the key point of the testing. This became part of the unhelpful defense of 'business as usual' by a thousand critics at the time. As the Club of Rome authors wrote, 'In terms of exact predictions, the output is not meaningful' (1972: 94). Rather, the key here is the relational output understood in terms of alternative scenarios. They could not have known for example that China would introduce their one-child policy in 1979, with around 500 million births said to have been prevented across the ensuing four decades. From the perspective of the central argument of this essay, the key question was not how good were their predictions, but why were critical political and cultural decisions seen as post facto issues raised by the method rather built into its core from the beginning (more of this later).

In summary, the Club of Rome authors worked with only a small number of economic and ecological themes—population, agricultural production, industrial production, non-renewable resource use and pollution—and given the limits of their approach together with the new capacities of computers for handling algorithmic complexity we would expect that more recent work to provide more integrative dimensions in their calculations. This does not appear to be the case. There are now numerous different Integrated Assessment Models (IAM). In the subfield of climate modelling alone there are a baffling number of systems approaches. However, as summarized by Zheng Wang, Jing Wu, Changxin Liu and Gaoxiang Gu using an already-established breakdown of types of Integrated Assessment Models, these different models are all narrowly conceived:

> (1) Cost-benefit analysis IAM for policy optimization, such as CETA, DICE, FUND, ICAM-3, MERGE, and the MiniCAM. These models firstly care about the economic consequences of climate change, such as comparing costs for climate change adaption and emissions reduction to assess possible alternative policies. In these models, climate modules are under 2 dimensions, some even are 0 dimension ... they can be used to rapidly evaluate emissions reduction agreement, such as Kyoto Protocol.
> (2) Biophysical-impact based IAM for policy evaluation, such as CLIMPACTS, ESCAPE, IMAGE and IGSM. These models are more focused on quantitative evaluation of the biophysical rather than economic policy evaluation. They tend to be analyze at the regional level, some analysis can also be integrated into the global level. The advantage of these

models is to analyze the impact of climate change on the high spatial resolution ... Economic module often contains only GDP, population and energy use.

(3) Policy guidance IAM, such as ICLIPS. It transfers economic losses (plants, agriculture, water resources) module through climate impact response function into tolerable windows. Tolerable window is generally expressed by the rise of temperature, rainfall and sea level rise level. These restrictions are input into greenhouse gas emissions-climate change module to calculate carbon emissions that can keep consistent with tolerate window. This model can be used to calculate the threshold value of climate change (2017: 3. Note the grammar is as in the original)

Thus, for all of the good intentions of the authors of various Integrated Assessment Models, the radicalism of the Club of Rome appears to have been lost in the search for increasing micro-certainty about economic-environmental relationships. More pointedly, for our argument, none of the dynamic systems approaches have gone beyond economic-environmental variables in their understanding of the determinatives of change. To be sure, there are impressive developing systems such as the MEDEAS-World model, a global economy-energy-environment model that presents a global dynamic system encompassing the period 1995 to 2050 (www.medeas.eu/model/medeas-model). The strength of this model is that it does not attempt to be predictive, but rather it projects possible scenarios in energy transition given changes in different domains of activity. And it does appear to bring in broader social questions: apart from the core domain of renewable and non-renewable energy resources (laudably considering biophysical and temporal parameters that are usually ignored), the other domains are economy, infrastructure, materials, land-use, climate change and what they call 'social and environmental impact'.

Yes, with the naming of that last domain, questions of social impact appear to be under consideration. However, there are two major problems with this model which mean that the naming of the social is counterproductively misleading. The last domain is not dynamically connected to the rest of the model. It does not feed back into the outcomes of the different scenarios (Capellán-Pérez, 2017). And it is certainly not determinative. In other words, human practices across the domain of culture (that is, meaning, including ideologies of climate-change denial or deferral) and politics (that is, power, including policy changes) have no bearing on the variables of change. In a world where, arguably, humans and their culture and politics play *the* major role in the direction of the planet—that is why this period is called the Anthropocene—this remains a significant problem.

Second, when one goes into the fine detail of the model it becomes apparent the variables in this domain are not actually cultural or political at all. What they call 'social indicators' are limited to the domains of economics and ecology, many variables of which are already being measured: fuel consumption, electricity consumption, water consumption, the potential Human Development Index level given energy-use, consumption of renewable energy sources (RES), share of RES in total final consumption, annual penetration of RES in the total final and primary energy consumption, Gross Domestic Product (GDP) per capita, jobs associated to RES technologies, 'estimation per electricity generation technology' of the system, green-house gas emissions, atmospheric green-house gas concentration levels, and temperature increases over pre-industrial levels. There are thus lots of 'social' variables, but none are cultural or political in their primary orientation.

Third, it is made ideologically worse by the authors of MEDEAS arguing that because they have taken one of the indicators of the Human Development Index, namely GDP, the whole set provides an indication of wellbeing—as if the Human Development Index itself is a proxy of wellbeing, much less GDP. All of this makes the model circular, but in an almost tautological rather than holistic or integrative way.

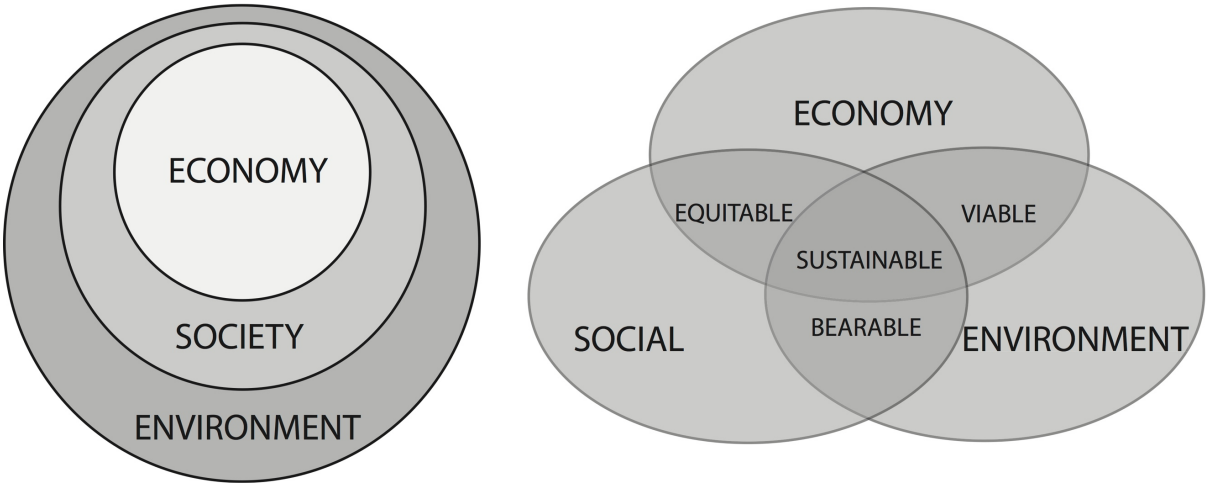
Finally, there is the practical question. Given the urgency of the issue, one point is worth considering. In the relatively short period since the Club of Rome wrote their report, substantially more human-produced greenhouse gases have entered the atmosphere than during all the prior years, centuries, and millennia of human history.

The 'Circles of Social Life' Method

The *Circles* method starts from a very different theoretical place, an integrative systems model that is qualitative at its basis *before* deriving quantitative indicators or variables. It is grounded in claims about the integral importance of politics (power) and culture (meaning) to all human practice—at the same time as recognized two other domains that are now always in contention: economics (resource-use and management) and ecology (integration within and with the environment). These domains are 'interwoven', to use Liam Magee's felicitous metaphor (2016).

The method had its beginnings in the early 2000s with a small secretariat of the United Nations: the Global Compact Cities Programme. That Programme sought an alternative framework for guiding cities towards positive sustainability from the dominant Triple Bottom Line approach (Figure 1), an approach that still holds rhetorical sway in policy discourse. The ever-more dominant position of economics was distorting urban development. An alternative was needed that was both practical and conceptually sensitive to the way in which dominant ideologies of growth, return on investment and technological fixes were driving (and skewing) social practice, including urban policy-making and corporate priorities.

Figure 1. Two Figurative Versions of the Triple Bottom Line Domains



To cut a long story short, the Circles method begins by making the claim that it is both heuristically useful—and now existentially necessary in the Anthropocene—to consider all questions of social life holistically across integrated set of *social* domains: ecology, economics, politics and culture (James, *et al.*, 2015). These domains were chosen through an extended period of global consultation as the simplest contingent set that most effectively represents the full complexity of human engagement in the world (see Figure 2 below). This does not just involve adding the domain of culture as a fourth domain to the Triple Bottom Line domains of the economic, environment and social. Rather, it involves recasting the meaning of all current approaches, in particular those which treat domains as separate or autonomous areas of practice and meaning that are partially brought back into intersection (Figure 1).

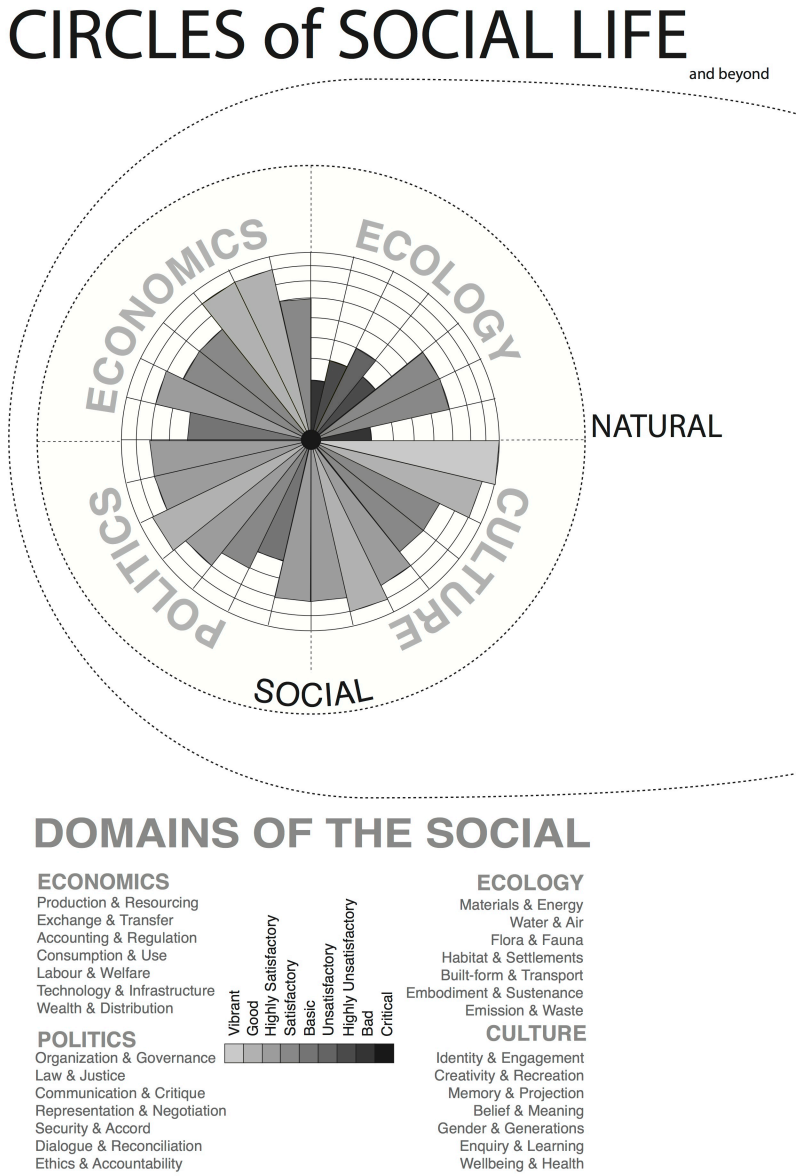
By comparison with the Triple Bottom Line argument and kindred approaches, the Circles method treats the economy and its avatar 'the market' as always-already inside the social rather than running free as a self-managing master system—a magisterial status that was conferred on it as late as the middle of the twentieth century. In this sense, the Circles method rejects particularly those approaches which treat sustainability as the narrow intersectional outcome of economic 'restraint' or involves treating elements of the environment as externalities to be treated in accountancy terms as mere resources or 'ecosystems services'. It does not attempt to cover the environment-in-general, a never-ending materiality that goes far beyond the human. Rather it focusses on 'ecology', understood—by a metaphorical extension of the original Greek sense of *oikos*—as the place, the terrain, the earth, through which humans live in the environment.

Much more than just a domain-based figurative representation, the Circles method builds on this conceptual base to offer an integrated set of tools for practically responding to issues of intersecting

social complexity: sustainability, vitality, productivity and relationality. These are not idly thrown-together terms, but integral to the method (James, 2018). The Circles method takes an urban area, city, community or organization through the difficult process of responding to complex or seemingly intractable problems and challenges, defined as sets of critical issues.

The method thus provides a way of responding to a series of questions. Firstly, how are we best to understand and map the vibrancy of social life in our cities, communities and organizations, treating this question in all its complexity across those four domains—economics, ecology, politics and culture? Second, what are the central critical issues that relate to making the city or community more vibrant? Third, what should be measured and how? Instead of designating a pre-given set of indicators, the method provides a process for deciding upon indicators and analysing the relationship between them. Fourth, it provides a process pathway for showing how positive responses can be planned. The method provides a series of pathways for achieving complex main objectives. It offers a deliberative process for negotiation over contested or contradictory critical objectives and multiple driving issues in relation to those main objectives. Finally, it supports a monitoring and evaluation process and a reporting process.

Figure 2. A Representation of the Circles of Social Life Domains



What do the Metaphors of 'Metabolism' or 'Circles' Mean for Understanding Systems Complexity?

Most systems approaches are built around the metaphors of metabolism (flows), networks (connections) or circles (domains). The key issue here is not which metaphor we use, but how we use it, sensitive to its orienting ideologies and framing imaginaries. The first two metaphors tend to emphasize mobility and change, while the third tends to emphasize relations—the relationality of domains of social life, and the relation between the social and the environmental. The problem here is not the metaphorical emphasis, but the way in which the first two tend to be uncritically favoured, either because mobility and change are central to the contemporary global imaginary or because it is easier empirically to measure flows than relations. Perhaps a third reason is a concern with metaphors of boundaries and limits. For example, Bruno Latour, who favours the concept of networks, argues that because the centring of humans in a circle of relations has commonly been treated anthropocentrically, and because. 'even more bizarre ... this circle has such well-defined boundaries', that we should drop such talk of circles altogether (2017: 86). Here is strangely forgetting that the figure of a circle is only a metaphor (and that it can be represented with dotted lines as in Figure 2 to signal the issue of contingently bounded relations). He is equally overlooking the issue that he falls back to treating networks as simple flat actualities, rather than as the ideologically imbued metaphorical *descriptions* of the world that inform practice. Over the past two decades, networking has come to be treated a normatively charged 'virtue', and writers such as Latour comfortably ignore this history.

The metaphors of metabolism and networks have an intersecting conceptual history in pre-nineteenth century discourses on the human body that tends to hide their ideological meaning. They are the metaphor for the flows that keep a living organism alive. As such, they can be sensitizing metaphors that bring time, connectivity, and change to the fore. Alternatively, they can be reduced to medicalized models of social processes that naturalize the ideology of flows, as if to slow down a flow is to confront death, stasis, or recession—all anathema to today's emphasis on movement and progress. As Grant Bollmer writes, 'this discourse has a history—one that depends on "truths" so deeply held that the materiality of the network seems to realize the promise of nature through the technological' (206: 45). When treated akin to Harvey's classic focus on the circulation of blood in the human body, part of what came to be known in the medical sciences as an automatic system, the focus on measuring metabolic flows accurately can also miss out the critical contingency of social action as more than just an outside driver or pressure to be noted in the background while describing the larger schema.

Paulo Ferrão and John E. Fernández in their book *Sustainable Urban Metabolism* set out a sensitive version of the standard industrial ecology perspective. They use the metaphor of metabolism to emphasize the flow of material things: a 'city can thus be viewed as an organism with a metabolism that can be studied' (2013: 13). Metabolism in this sense is a necessarily reductive metaphor for a complex changing organism—including the social as a whole. It is necessarily reductive, and that is not bad in itself—all abstracting systems are reductive in different ways. However, he problems arise when, in reducing social complexity to a few material components in a stocks-and-flows chart, the metabolic model forgets that this is a redoubling reduction. As Neil Smith points out:

> The notion of metabolism sets up the circulation of matter, value and representations as the vortex of social nature. But, as the original German term, *Stoffwechsel*, better suggests, this is not simply a repetitive process of circulation through already established pathways. Habitual circulation there certainly is, but no sense of long-term or even necessarily short-term equilibrium. Rather *Stoffwechsel* expresses a sense of creativity in much the same way that Benjamin talks about mimesis: the metabolism of nature is always already a production of nature in which neither society nor nature can be stabilized with the fixity implied by their ideological separation. Society is forged in the crucible of nature's metabolism, for sure, but nature is equally the amalgam of simmering social change (Smith, 2006 p. xxiii).

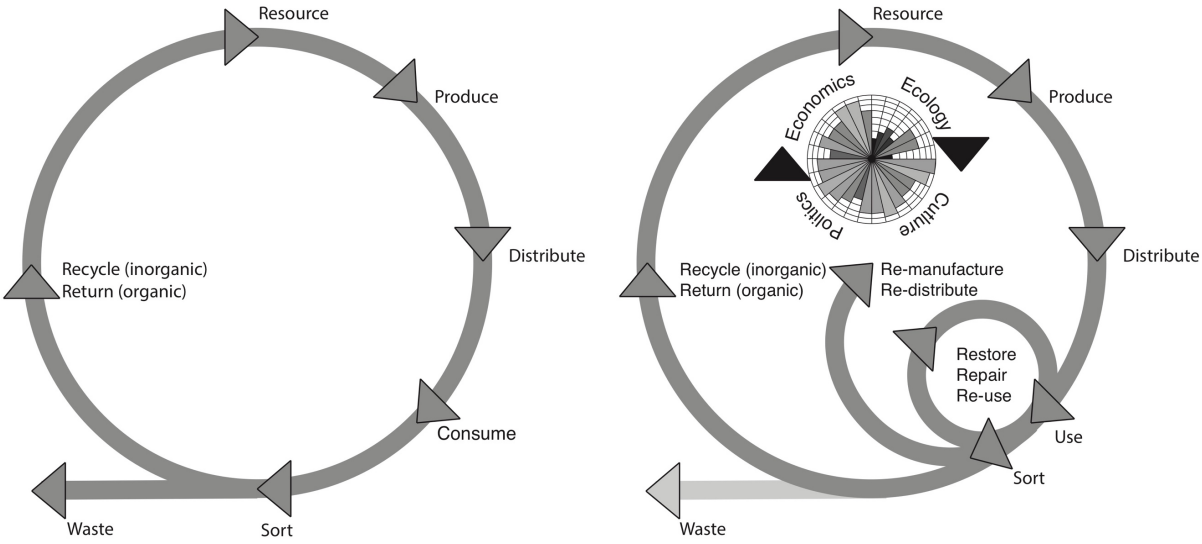
As Erik Swyngedouw similarly argues: 'Metabolism as a biochemical process is a contradictory one, predicated upon fusion, tension, conflict, and ultimately transconfiguration, which, in turn, produces a series of new "entities", often radically different from the constituting components, yet equally re-active' (2006: 26). The trouble with some of the radical and important intervention into metabolic

systems-building is that algorithmic mathematics cannot handle contradictory and tension-produced changes in form.

The Circles method builds on a different and no less difficult metaphor: the circle. The circle also has its own tendency towards being treated as virtuous, but this is much more mixed: the 'virtuous circle' is qualified by the equally possible 'vicious circle'; the 'circle of life' includes the stages of death and decay. The figure of the circle also faces the problem of presenting a pseudo-holism, with a modern line of sequencing such as 'paddock to plate' (the food system) or 'resourcing to using' (the circular economy) that are simply drawn into a circle without addressing the problems in the original line of sequencing.

The definition of the circular economy put by Jouni Korhonen, Jouni Honkasalo, and Jyri Seppälä illustrates this problem perfectly: 'Circular economy is an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow' (2017: 39). They proudly proclaim that theirs is 'the first attempt to present a scientific research-based definition of CE' (p. 41), but the definition is locked within an economistic paradigm where the circle is just the usual straight line, except drawn into a ring of rigorous resource-management with loops of enhanced extraction. It is possible to develop a version of the circular economy that is much less economistic (Figure 3. left-side diagram), but even this needs to be rethought by recognizing firstly that the circle needs to be drawn with inner circles of restoration, repair, re-use, as well as remanufacture and redistribution, Second, it needs to be recognized that as well as economic and ecological dimensions each of the steps also has political and cultural dimensions (Figure 3. right-hand diagram). In this second diagram, the circle of social life has been added as a way of signifying that a Circles' assessment has to be done at each point along the pathway of a circular economy. For example, without including a cultural understanding of consumption, including the pressures of commodity fetishism, the circular economy as a process is likely to go the way of the triple bottom line. It will become an excuse for ever-increasing consumption, only tempered by a machinery of waste recovery.

Figure 3. The Circular Economy



Work on food systems tends to confront the same problems as that of the circular economy. In this case they tend drawn the commodity-chain relation from paddock (production) to plate (consumption) into a weak circle by recycling food into the production cycle as green compost for manure. If food is part of the human condition—and, to take one example we know that food is foundational to defining cultural identity and sociality—then how can we begin to depict that condition in a way that at once remains holistic and allows us to demarcate the domains and subdomains that are relevant to food policy? Most pressingly, how can we do so without being overwhelmed by the usual starting point of

economics (production)? Some food systems approaches have begun to do this, but they tend to pass too quickly over the issue of what constitutes the circle of life. Usually, it is just a straight-line economic supply-chain: production-distribution-consumption-waste, with waste drawn back into a circular connection with production through composting organic matter.

One of the early classic versions of the food system tried to be circular in more holistic way through a three-domain model that begins with the biological, namely, 'the living processes used to produce food', then moving to the economic and political, the power exercised over the food system; and the social and cultural, 'the personal relations, community values and cultural traditions which affect people's use of food' (Tansey and Worsley, 1995: 4). This version has a wonderful generality and is much better than the usual Triple Bottom Line approach (Figure 1).

However, as soon as we start to interrogate the starting point for Geoff Tansey and Tony Worsley's work, as one example among many, it quickly becomes clear that they should have started from somewhere else. A few quick thought-experiments will be enough to complicate the directions we give for developing a positive model of food sustainability. If the first of their domains is the biological, 'the living processes used to produce food', where in this approach are non-organic fertilizers or fence-posts, cadastral maps or farms—non-living, non-biological things, all critical in the vast ecology of things, processes and spatialities that are part of the food system?

If their second domain is the economic and political—that is, the power exercised over the food system, does this mean that all economic questions are only or primarily issues of power? It is certainly the case that power relations beset the economics of production. But in trying to understand what it means when a peasant-farmer in Andes sows seed into harrowed ground, we need, even if only for policy and analytical purposes, to separate out questions of power—who controls the legal rights to the reproduction of that seed, for example—from economic questions such as what form of agricultural production frames the seed sowing.

And, if their third domain is cultural, 'the personal relations, community values and cultural traditions which affect people's use of food', where do we analyze the culture of capitalism, commodity fetishism, and ideologies of growth and technocratic development? These too are cultural issues, but none of them begin with personal relations or cultural traditions, even as they are instantiated in people's life-worlds and local practices. In short, their domains do not meet the requirements of adequate generality and analytical coherence.

What Should Be the Subject of a Metabolic or Circles Analysis?

Discuss the subjects — the reduction to 'water, materials, energy, and nutrients'

Kennedy, C., Cuddihy, J. and Engel-Yan, J. (2007), 'The Changing Metabolism of Cities', *Journal of Industrial Ecology*, vol. 11, no. 2, pp. 43–59.

According to Paulo Ferrão and John E. Fernández (2013), *Sustainable Urban Metabolism*

> Urban metabolism can be analyzed in terms of four fundamental flows or cycles — those of water, materials, energy, and nutrients, according to Kennedy et al. (2007). They suggest that differences in the cycles may be expected between cities due to age, stage of development (i.e., available technologies), and cultural factors. Other differences, particularly in energy flows, may be associated with climate or with urban population density. (p. xi)

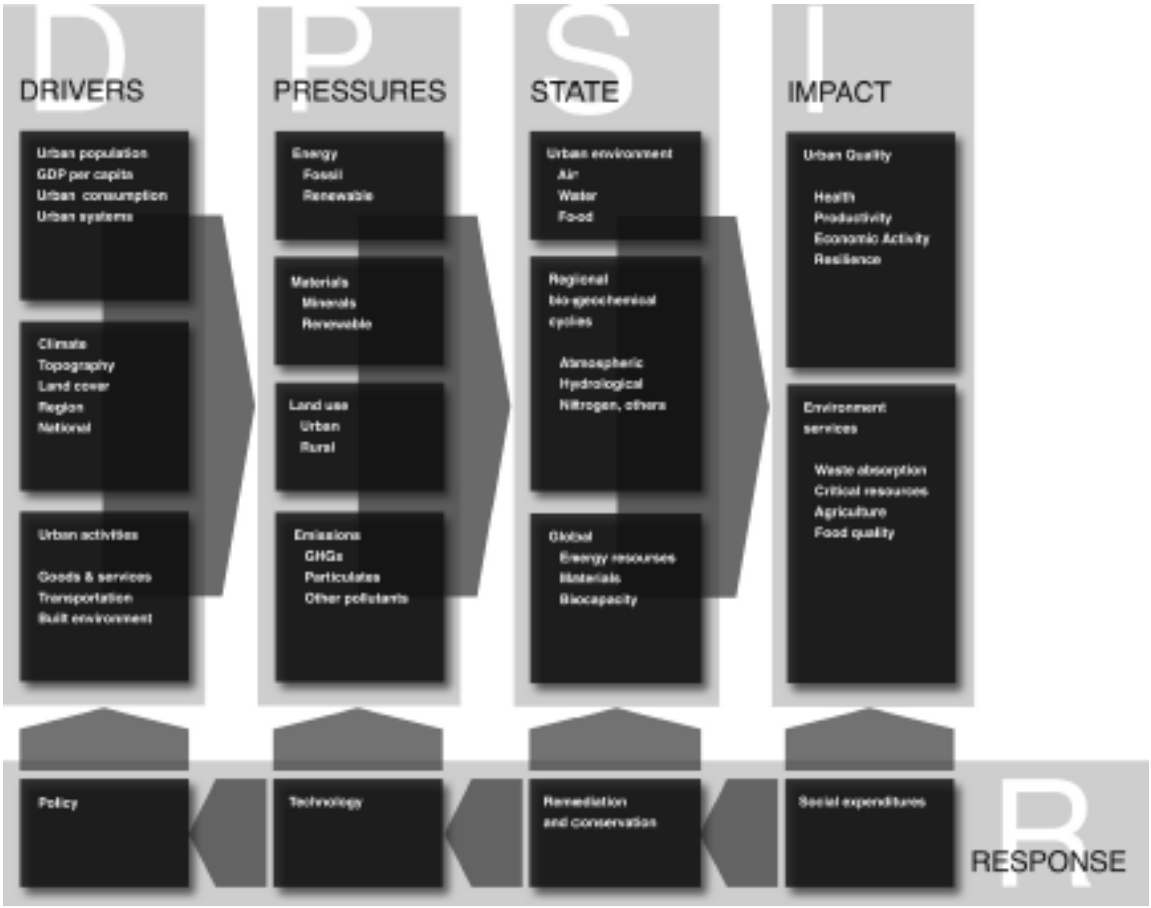
Can Subject-Based Approaches Bring in Complex Understandings of Process

Introduce the driver-pressure-state-impact-response (DPSIR) model and then show how the Circles approach would modify and complicate this.

According to Paulo Ferrão and John E. Fernández (2013), *Sustainable Urban Metabolism*, MIT Press, Cambridge, 2013:

> Alberti et al. (2003) proposed a conceptual model that links human and biophysical drivers, patterns, processes, and effects (DPPE), which we will call a DPPE model. In this conceptual model, drivers are human and biophysical forces that produce change in human and biophysical patterns and processes. Patterns are spatial and temporal distributions of human or biophysical variables. Processes are the mechanisms by which human and biophysical variables interact and affect ecological conditions. Effects are the changes in human and ecological conditions that result from such interactions. (p. 14)

Their counter proposal is the driver-pressure-state-impact-response (DPSIR) model (p. 15)



(p. 20 ‘A DPSIR framework for Urban Metabolism’

Does this Mean that Bio-metaphors or Bio-Mimicry is a Good way of Thinking of a Social System?

Bring in the elephants problem

Nature as Resource

Michael Pawlyn, ‘Using Nature’s Genius in Architecture’: ‘You could look at nature as being like a catalogue of products, and all of those have benefitted from a 3.8-billion-year research-and-development period. And given that level of investment it makes sense to use it.’ www.ted.com/talks/michael_pawlyn_using_nature_s_genius_in_architecture?language=en

last accessed 21 February 2015. At that time there had been 1,276,745 total views of the video.

Conclusion: Crisis or a Return to the *Art of Living*

As the Club of Rome researchers write in 1972, 'Any human activity that does not require a large flow of irreplaceable resources or produce severe environmental degradation might continue to grow indefinitely. In particular, those pursuits that many people would list as the most desirable and satisfying activities of man [sic]—education, art, music, religion, basic scientific research, athletics, and social interactions—could flourish.' (Meadows, *et al.,* 1972: 175). Their words echoed those of John Stuart Mill, writing a century earlier in 1857: 'It is scarcely necessary to remark that a stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress; as much room for the Art of Living and much more likelihood of its being improved' (Meadows, *et al.,* 1972: 175).

The difference now in the early part of the twenty-first century is that the poignancy of Mills' words, it 'is scarcely necessary to remark', have a new resonance. The art of living cannot be taken for granted. More than a century-and-a-half later we can no longer take such a sentiment for granted. We have to shout those words. And even then, they tend to disappear into the global cacophony of superlative comparisons.

⇨ The Club of Rome overlooked, or rather took for granted, questions of culture and politics.

Korhonen, Honkasalo, and Seppälä

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